

Review Article

Foundation of Global Epizootiology – a New Branch of Life Sciences

Václav Kouba

*Department of Animal Science and Food Processing in Tropics and Subtropics,
 Faculty of Tropical AgriSciences, Czech University of Life Sciences Prague, Czech Republic
 Former Chief, Animal Health Service, Food and Agriculture Organization of the United Nations, Rome, Italy*

Abstract

Globalization era starting in full in the 1990s brought entirely new conditions for epizootic disease spreading and control at global level. Significantly intensified global trade in animals and their products without any effective sanitary filter has facilitated mass worldwide spreading of the pathogens. Huge daily flow of exported non-pathogen-free animal commodities has led to rapid deterioration of global epizootiological situation. Never in the history did global occurrence of animal infections worsen as in present time when the amount of scientific knowledge is the largest in human history. Thus an important gap occurred in the structure of life sciences. No institution has yet started to fill this gap with missing scientific branch dealing with planet-wide epizootiological triad (animals – pathogens – environment) as with one compact dynamic biological system within the biocoenosis envelope surrounding the Earth. There has been an urgent need to develop new epizootiological methods in order to achieve desirable results in the protection of animal population health covering our entire planet. The author therefore used the opportunity provided by ResearchGate network. This made it possible to start a “Global Epizootiology” project as a new scientific branch dedicated to population health and epizootic disease control of all species of animal kingdom in the whole world. Its definition, objectives and content have been formulated. In conclusion, anthropocentric priorities have to be the protection of world human population against diseases transmissible from other species and global production of safe food of animal origin. During the first year ResearchGate Global Epizootiology Project reached 1,159 publications and update reads.

Keywords: animal infection globalization; global biological terror; global epizootiological situation; global infection eradication; global veterinary medicine; non-pathogen-free trade; irreparable pathogen spreading.

INTRODUCTION

The globalization era brought entirely new conditions for epizootic disease spreading and control at global level. This contribution describes the start of “Global Epizootiology” as a new scientific branch dealing with global animal population health and epizootic diseases. International and intercontinental trade in animals and their products without effective sanitary filter (based upon polyetiological investigations) facilitated globalization of pathogens causing incalculable numbers of diseased and prematurely dead animals and humans. The main impulse for founding “Global Epizootiology” as a new branch of life sciences structure was mass globalization of animal infections through “legal” international trade. In spite of repeated warnings, this fact was ignored by relevant international organizations such as World Trade Organization (WTO) and World Organization for Animal Health (until 2003 Office International des Epizooties – OIE) responsible for the protection of animal populations against epizootic diseases. This unacceptable

phenomenon representing the highest grade of internationalization of infected animals was ignored also by other relevant international organizations and animal health research/education institutions. This paper is based upon analyses presented in a set of contributions entitled “*Irreparable global spread of pathogens and international trade*” subdivided in “*facilitating factors*”, “*infection monitoring*” and “*sanitary requirements*” published in *Agricultura Tropica et Subtropica*, Faculty of Tropical AgriSciences, Czech University of Life Sciences, Prague (Kouba, 2014, 2015). Particular attention was paid to critical analyses of international documents regulating trade in animals and their products: *OIE Terrestrial Animal Health Codes* and *WTO Agreement on Sanitary and Phytosanitary Measures (SPS)*. Several examples representing some of the factors facilitating globalization of animal pathogens through international trade are included (Caporale, 1994; WTO, 1995; OIE, 1997–2016; Hodges, 2001; Zepeda et al., 2001; Ozawa et al., 2003; Rweyemamu et Astudillo, 2003; Marano et al., 2007). There are many publications

on global occurrence of selected specific infections, mainly in compilation form only, such as Murray et al. (2004).

Note: The term “*pathogen*” used in this text means an infectious agent – a microorganism such a virus, bacterium, prion, fungus and protozoan as well as parasite, causing transmissible epizootic disease in its animal host. The term “*animal population health*” means “*epizootiological health*” = pathogen-free status.

Justification

The foundation of the “Global Epizootiology” is the response to the globalization of animal infections. Man-made global mass spreading of invisible pathogens with multiplying sanitary, economic, social and ecological consequences (gradually increasing over time) represents a worldwide threat contributing to shortening life on Earth, to the extinction of globally affected animal species and to future gradual self-destruction of humankind. There has been an urgent need to develop epizootiological methods for the new reality covering our entire planet. No institution has founded a particular scientific branch dealing with global epizootiological triad (animals–pathogens–environment) as with one compact dynamic biological system within the biocoenosis envelope surrounding the Earth. Main exporting countries and supranational trade organizations exploited the globalization era for a substantial increase of international trade in animals and their products. They achieved a series of unfair exceptions in WTO and OIE documents making possible also to export animal commodities not free of infection pathogens. The worldwide trade in non-pathogen-free animals and their products has led to irreparable global spread of animal infections (global biological terror). Successful results of antiepzootic work of many generations of veterinarians have thus been devalued and mainly irretrievably lost.

An example of the immense size of international trade in animals and of incomplete sanitary control: “*The magnitude of the global movement of animals is staggering. In terms of sheer numbers, 37,858,179 individually counted live amphibians, birds, mammals, and reptiles were legally imported to the United States from 163 countries in 2000–2004. For the most of these animals, there are no requirements for zoonotic disease screening either before or after arrival into the United States.*” (Marano et al., 2007).

Among the factors facilitating animal infection globalization belong: difficult-to-control countless pathogen species able to reproduce and spread horizontally as well as to the next generations causing an immense number of diseases (sufferings) and premature deaths of infected animals and humans; intercontinental export of animals and their products; international sanitary certificates without

pathogen-free guarantee; inability to discover all imported pathogens and to eradicate them; absence of pathogen export/import monitoring etc. International animal health information system covers only a very small part of animal infections and provides insufficient data on their occurrence. The importing countries have minimal or zero information for objective risk assessment to avoid pathogen introduction.

The WTO and the OIE do not require exported animal commodities to be of full sanitary quality, i.e. to be pathogen-free. They unilaterally support the exporting countries at the expense of health and life in the importing states that are not self-sufficient in animal production. Thus a worldwide spreading of pathogens through “legal” trade occurs. These bodies ignore global irreparable sanitary consequences of their unfair policy. They deprive the importing countries of freedom to reject animal commodities having no sanitary innocuousness guarantee (without written convincing risk assessment; risk of international arbitration). They ignore scientific knowledge such as pathogen reproduction, resistance, survival, changing, adaptation, mutation and spreading abilities. They ignore the ability of pathogens to increase virulence when newly introduced to specifically susceptible populations. All pathogens cause disease, many of them are “killers” (some are even on the list of biological weapons), some damage the reproduction process of the host organisms and the possibility cannot be excluded that some pathogens could destroy their gene structures. Emerging pathogens represent a dangerous threat.

The original OIE principle for international trade in animal commodities “*to avoid the risk of spreading animal diseases inherent in such exchanges*” (OIE Code, 1992) was replaced by supporting trade also to the detriment of animal and human health and life in importing countries: “*Import risk analysis is preferable to a zero risk approach*” (OIE Code Special Edition, 1997, art. 1.4.1.1). In an OIE publication (Murray et al., 2004) there is even a sentence “*A zero risk importation policy...would require the total exclusion of all imports*” threatening importing countries if requiring pathogen-free animal commodity. The OIE was thus converted into a subordinated position to the WTO. Admitting pathogen spread through international trade is in stark contrast to the OIE’s single and unique duty and to global sustainable development policy (“*why bother about the future?*”). Sanitary requirements for animal commodities are for exporting countries and supranational trade organizations non-tariff barriers “complicating” their export aimed at maximum profit through minimizing cost of antiepzootic measures at the expense of the health and life in importing countries (the cheapest requirements, i.e. zero requirements).

An example of imposing sanitary requirements reduced *ad absurdum* to facilitate animal commodity

export: V. Caporale, former President, OIE Scientific Commission for Animal Diseases: *“The need to remove technical obstacles to the free circulation of animals and their products”*; *“It is no longer possible to apply the old system under which animals and animal products had to come from specific free zones, and were subjected to isolation, quarantine, inspection and diagnostic testing before and after export.”* This “philosophy” has conducted to internationalization of many animal infections without their follow-up eradication.

Government animal health services were drastically reduced and have lost their ability to effectively control international trade, i.e. they have not been prepared for the globalization era.

Examples: *“the privatization of veterinary services, thus aiming at drastically diminishing the role of the state in these activities. Surveillance, early warning, laboratory diagnostic services, planning, regulation and management of disease control programme, as well as ensuring the quality and safety of animal products were secondary considerations. The chain of veterinary command that required notification of disease outbreaks enabling a response to disease emergency and which also ensured the management of national disease control programme, was often dismantled.”* (Rweyemamu and Astudillo, 2003). Similar drastic reduction of government animal health services happened even in rich developed countries such as Japan and Korean Republic (Ozawa et al., 2003). Missing control of international trade conduces also to violating laws: *“A large United Kingdom rendering company continued and expanded its export of meat and bone meal, which may have been contaminated with BSE, for 8 years after EU ban in 1988, to 70 countries in the Middle and Far East.”* (Hodges, 2001).

The pathogens can be spread to the other end of the world through the export of only one animal “pathogen carrier” or infected animal product even during only one day. The import of pathogens is relatively easy but their timely discovery is rare and their eradication to avoid further spreading is very difficult if not impossible.

It is logical that when there is no requirement for exporting pathogen-free animal commodities then it means to accept also “legal” export of pathogens, i.e. of infections! Unfortunately, animal health research and education institutions have been unconsciously (*“silence means consent”*) or consciously or even demonstratively supporting WTO and OIE unfair trade policy ignoring the consequences of global spreading of pathogens.

Example: The paper of Zepeda et al. (2001) demonstratively supporting WTO and OIE unfair trade policy was first presented at the Plenary Session of the Ninth Symposium of the International Society of Veterinary Epidemiology and Economics (ISVEE), Breckenridge, Colorado, USA, 7–11 August 2000.

Never in the history did the global occurrence of animal infections worsen as at present (up to irreparability), paradoxically at a time when the volume

of scientific knowledge, the numbers of veterinarians (approaching one million), veterinary faculties (more than half a thousand), meetings, conferences and publications are the largest in history.

Global Epizootiology Foundation

The author exploited the chance offered to him by international ResearchGate network programme when being asked in September 2016 for a new project. He entitled it “Global Epizootiology” as a new branch so far missing within the structure of the life sciences. It is dedicated to global animal population health and epizootic diseases. Global interaction of worldwide pathogenic microflora, animal kingdom and environment is considered to be the largest epizootiological unit and as such it is necessary to study it and solve relevant global problems. The main anthropocentric objectives of action-oriented and problem-solving “Global Epizootiology” are: the protection of the whole human population against diseases transmissible from other animal kingdom species and the betterment of global production of food of animal origin.

Global Epizootiology definition

“Global Epizootiology is a science which studies origin, distribution, frequency, development, determinants and extinction of animal population health and epizootic diseases at global level and based on their analyses defines and applies methods for creation, promotion, protection and restoration of population health by reducing, eliminating and eradicating specific diseases in the whole world”.

Notes: Name is from Greek: *epi*=upon; *zoon*=animal. Epizootiology covers all species of animal kingdom. From biology science hierarchical point of view the epizootiology includes also the humans belonging to the animal kingdom: *“Strictly speaking epizootiology is a more inclusive term than epidemiology.”* (Schwabe, 1969).

Selection and practical application of the most suitable epizootiological methods reaching with minimal inputs the best possible results in global animal population health protection and recovery programmes, is a very demanding professional art.

Global Epizootiology content

The “Global Epizootiology” consists of “General Global Epizootiology” and “Specific Global Epizootiology”. The first is dealing with global principles and methods for all animal infections while the latter with global principles and methods for specific animal infections.

The majority of “General Epizootiology” principles are applicable also in “Global Epizootiology” while the methods are very different as far as size, complexity, demandingness, duration, number of components and influencing factors are concerned. Global

epizootiological processes are based upon unpredictable pathogens as unquantifiable biological phenomena in continuing changes and development. "Global Epizootiology" framework covers all epizootiological processes in all animal populations of all species and all pathogens causing communicable animal diseases within the whole biocoenosis surrounding our planet (colonization/pollution by the pathogens). Global antiepidemic pyramid represents an interconnected united system of local, national, regional, continental and worldwide programmes; all are important.

Each component of the "Global Epizootiology" suggested below for further study, development and practical actions to be dealt with as an integral part of united planetary general or specific epizootiological systems: objectives, content and basic principles; animal populations and their characteristics of epizootiological significance; animal population resistance and susceptibility; animal population salubrity and survival (incl. reproduction turnover); animal population morbidity and mortality; animal population epizootiological structure (incl. mapping); communicable disease pathogens (incl. classification); pathogen sources; pathogen transmission (incl. mapping, propagation through trade, animal migration); influencing environmental factors; interaction animal population-pathogenic microflora-environment; epizootic process; occurrence/focality of animal infections (incl. mapping); zoonotic diseases; influencing economic/social factors; impact of animal population health and disease; epizootiological situation investigation (incl. polyetiological testing); epizootiological information system (incl. information technology); epizootiological situation analyses; epizootiological monitoring/surveillance; epizootiological theory, experiments and studies; epizootiological strategies and measures; active creation of animal population health; animal population general preventive measures; animal population specific preventive measures; territorial antiepidemic protection; animal population general health recovery measures; animal population specific health recovery measures (incl. eradication); measures against zoonotic diseases; epizootiological sanitation; planning of epizootiological measures; organization of epizootiological measures (incl. structure and management) and results/effectiveness of epizootiological programmes.

Global epizootiological triad is not a simple sum of all isolated sub-components (epizootiological triads of lower levels) in the world. It represents an integrated global system from all interconnected and interdependent sub-components of incalculable numbers (analogy to animal body built as an integrated system of all organs and cells). Even the local epizootiological triads need to be studied and solved in the global context. "Global Epizootiology" concerns

directly or indirectly all epizootiological processes on the Earth, i.e. population health and epizootic diseases of all animal species. It exploits also relevant information about epidemiology, microbiology (incl. bacteriology, virology etc.), serology, parasitology, zoology, animal husbandry, ecology, economics, biostatistics, information technology, management etc.

"Global Epizootiology" theoretical studies and practical activities need to be based on an inventory of global epizootiological problems. It is necessary to classify animal infections according to their global significance, e.g. as extremely important, very important, moderately important, less important and insignificant. This classification must consider a series of criteria such as global sanitary, economic, social and environmental importance. In each of these groups the sequence of specific infection importance to be corrected by the availability of suitable realistic methods of specific monitoring, control, elimination and eradication, by their global practical feasibility (incl. expected availability of necessary inputs), i.e. the probability to achieve planned global objectives ("probability of success").

On the basis of such comprehensive analyses the time order of global antiepidemic programmes has to be determined: specific infection global time-bounded eradication (with concrete deadline), specific infection global eradication without concrete deadline, specific infections in preparation phase for its future global eradication, specific infections to be globally controlled to reduce morbidity, mortality and focality, specific infections to be globally monitored only (combined with protective measures), specific infections to be globally handled in the future and specific infections to be for the time being removed from global antiepidemic programme. For the above global classification of animal infections it can be recommended to use numeric grading.**)

**)Example: In <http://vaclavkouba.byln.cz/epiexamples.htm> of the EPIZOO software package there is an example (Modul9.1) of priority disease selection for animal health programs – assessment of eligibility according to grades (from 0 to 10) of specific disease biological, economic, public health and social importance (corrected by multiplier coefficients), of technical solution feasibility and of inputs availability after analyzing all substantial factors influencing strategy/measures practicability and probability of success. Particular "know-how" is in Modul9.1 of <http://vaclavkouba.byln.cz/epimethodology.htm>.

DISCUSSION AND CONCLUSION

The role of the "Global Epizootiology" is to provide convincing professional arguments based upon thorough analyses of concrete facts collected through new global comprehensive information system on

epizootiological situation in all countries and to present feasible recommendations for follow-up global antiepidemiological actions. First steps should be dedicated to the analyses of animal infection disease globalization through international trade in animal commodities to get enough arguments for the abolishment of WTO/OIE unfair trade policy conducting to global spread of the pathogens. In this context there is a need to start immediately specific monitoring, i.e. to restore and significantly improve regular reporting on infection occurrence and on pathogen introduction through international trade (abolished by the OIE in 1996, i.e. avoiding to monitor this phenomenon) and to restore and significantly improve previous classification of animal diseases according their importance (abolished, together with numeric classification, by the OIE in 1998).

Note: FAO EMPRES-i Global Animal Disease Information System, contributing to the joint FAO/OIE/WHO Global Early Warning and Response System (GLEWS) enhancing response to transboundary and high impact animal diseases, does not solve the globalization of animal infections through trade.

A new international trade policy concept of “*health/life over trade/profit*” replacing the actual “*trade/profit over health/life*” one to be elaborated and enforced. This action will contribute to importing country protection against the introduction of the pathogens through trade and to exporting country motivation for improving national epizootiological situation, incl. eradication of relevant infections, to can export pathogen-free animal commodities.

Priority identification of global epizootiology research programmes is an extremely difficult task. The same goes also for the selection of particular infections for realistic global monitoring, control and eradication. Every country has different epizootiological situation, conditions for the pathogen spreading, animal health services, social-economic conditions, national priorities/interests and public/government supports. Every infection has different worldwide importance, characteristics and methods for their global control and eradication. Every global antiepidemiological programme has different manpower, material, financial and managerial requirements. The overwhelming majority of animal infections have not yet available realizable global eradication methods. Specific infection global eradication pyramid based upon all local, national, regional and continental programmes requires very demanding vertical and horizontal coordination and management. Global epizootiological diagnosis as the result of epizootiological investigations, based mainly upon mass clinical and laboratory etiological screenings, has a key role for antiepidemiological strategy/measures decision-making supported by research results and available resources. Irreplaceable worldwide

practical field activities at population level are decisive for achieving global antiepidemiological targets. *Acta, non verbal!* “Yes” for pathogen-free trade, “no” for pathogen export! “Yes” for animal population health globalization, “no” for animal infection globalization!

Only one animal infection has been globally eradicated so far – rinderpest in 2010, following human pox in 1980 (Fenner et al. 1989), after one century of extraordinary exigent programme. Rich experience accumulated during this programme, documenting the feasibility of global eradication of selected infections of domestic and wild animals, to be exploited. Actual PPR (*Peste des petits ruminants*) global eradication programme (deadline: 2030) under the leadership of Animal Health Service, FAO of the UN to be welcome and supported.

A seed of the Global Epizootiology was planted to be developed and to continue throughout the existence of humanity permanently endangered by animal infections. It is expected the followers (who care for the global sustainable development on our planet and the longest existence of humanity) to finalize and further develop individual components of the Global Epizootiology as indicated by the author in his initial updates of this ResearchGate project. Among the updates several basic principles, instructions, texts and sources concerning detailed justification, education and training (syllabi, textbook, teaching charts etc.), indicators, software, etc. are already available for everybody in the ResearchGate network. Further updates follow.

REFERENCES

- Caporale V. (1994): Harmonization of activities of the veterinary services in Europe with special respect to principles of certification and to accreditation of European laboratories and the mutual recognition of analysis results. Document for OIE European Commission, 22 p.
- Hodges J. (2001): Editorial. *Livestock Production Science* 69: 59.
- FAO/OIE (2015): Global strategy for the control and eradication of PPR (*Peste des petits ruminants*). FAO, Roma, 81 p.
- Fenner F., Henderson D. A., Arita I., Jezek Z., Ladnyi I. D. (1989): Smallpox and its Eradication. World Health Organization (WHO), Geneva, 1421 p.
- Kouba V. (2002): History of diseases spreading through international trade – lesson for the future. *World Veterinary Association Bulletin* 19 (1): 18–21.
- Kouba V. (2003): Globalization of communicable diseases of animals – a crisis of veterinary medicine. *Acta Veterinaria Brno* 72: 453–460.
- Kouba V. (2013): Rinderpest Global Eradication Management. *Agricultura Tropica et Subtropica* 46(2): 35–42.

- Kouba V. (2014): Irreparable Global Spread of Pathogens and International Trade – Infection Monitoring. *Agricultura Tropica et Subtropica* 47(4): 147–154.
- Kouba V. (2015): Irreparable global spread of pathogens and international trade – facilitating factors. *Agricultura Tropica et Subtropica* 48 (1): 37–43.
- Kouba V. (2015): Irreparable global spread of pathogens and international trade – sanitary requirements. *Agricultura Tropica et Subtropica* 48 (3–4), 105–114.
- FAO (1956–1995): FAO/WHO/OIE Animal Health Yearbook. FAO, Rome.
- Marano N., Arguin P. M., Pappaioanou M. (2007): Impact of Globalization and Animal Trade on Infectious Disease Ecology, Vol. 13, No 12. Centers for Disease Control and Prevention, Atlanta, Georgia, USA.
- Murray N., MacDiarmid S. C., Woolridge M., Gummow B., Morley R. S., Weber S. E., Giovannini A., Wilson D. (2004): Handbook on Import Risk Analysis for Animals and Animal Products. Vol. 1. OIE, p. 20.
- Murray C. J. K., Lopez A. D., Mather C. D. (Eds). (2004): The Global Epidemiology of Infectious Diseases. Global Burden of Disease and Injury Series, vol. IV. World Health Organization, Geneva. 390 p.
- OIE (1997–2016): Terrestrial Animal Health Code. OIE, Paris.
- Ozawa Y., Chang K., Yoshida K., Michino H. (2003): The present and future organization of Veterinary Services in Asia: The examples of the Republic of Korea and Japan. *Revue Scientifique et Technique OIE* 22 (2): 499–508.
- Rweyemamu M. M., Astudillo V. M. (2003): Global perspectives for foot and mouth disease control. *Revue Scientifique et Technique OIE* 21(3): 765–773.
- Schwabe C. (1969): *Veterinary Medicine and Human Health*. Baltimore: Williams and Wilkins, p. 163.
- WTO (1995): Agreement on Sanitary and Phytosanitary Measures (SPS). WTO, Geneva.
- Zepeda C., Salman M., Ruppaner R. (2001): International trade, animal health and veterinary epidemiology: challenges and opportunities. *Preventive Veterinary Medicine*, 48: 261–271.

Received: April 7, 2017

Accepted after revisions: December 6, 2017

Corresponding author:

V. Kouba

Faculty of Tropical Agrisciences
Czech University of Life Sciences Prague
Kamýcká 129
165 21 Prague, Czech Republic